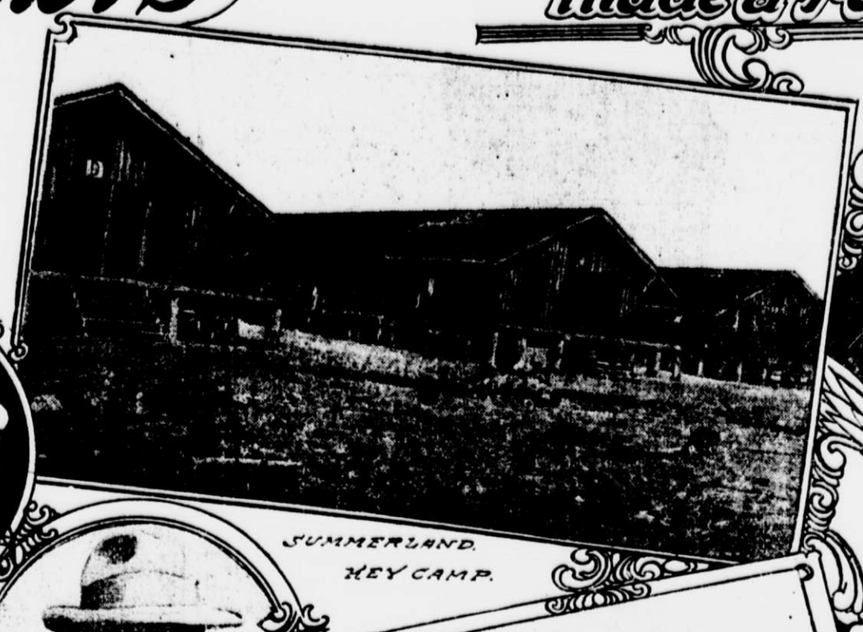
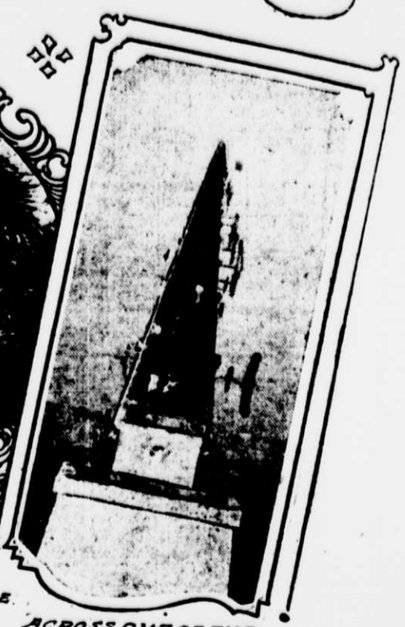
H. M. Flagler's Dream of a sea going railroad to Key West made a reality.

HENRY M. FLAGLER.



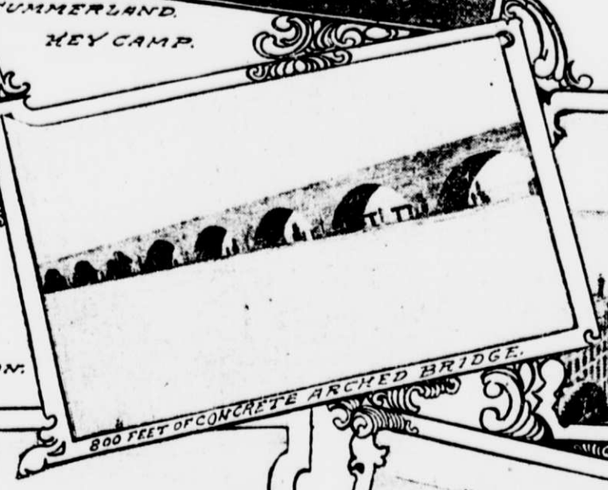
SUMMERLAND KEY CAMP.

JUNGLE THROUGH WHICH SURVEYORS RAN THE LINE.

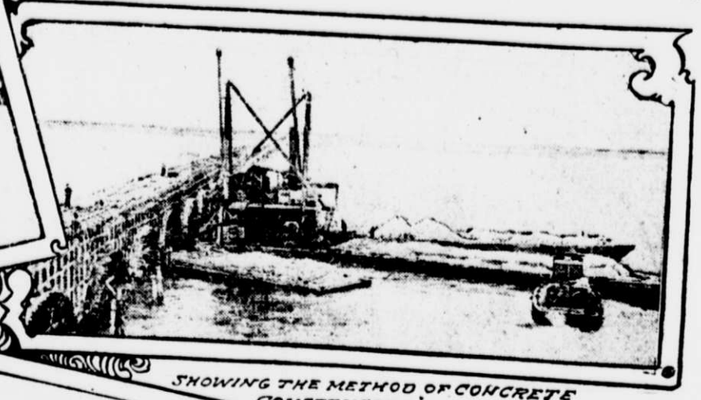


ACROSS ONE OF THE BIG BRIDGES.

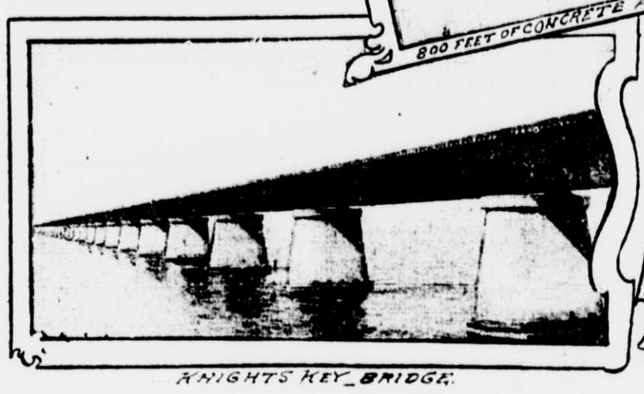
WILLIAM J. KROME, CONSTRUCTING ENGINEER OF THE KEY WEST EXTENSION.



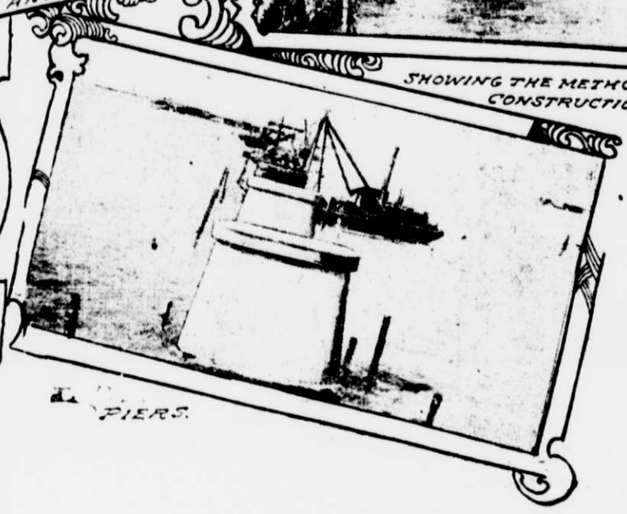
800 FEET OF CONCRETE ARCHED BRIDGE.



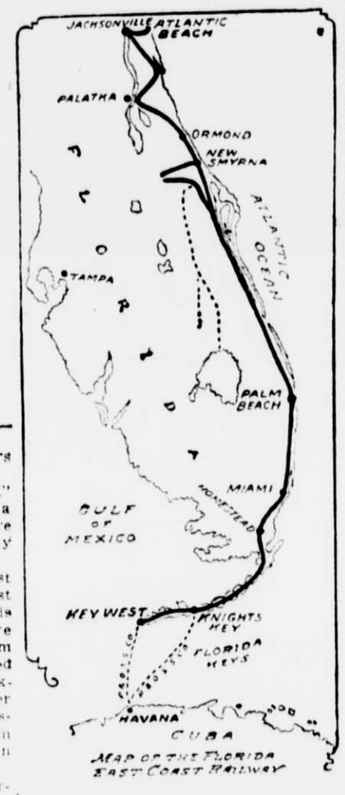
SHOWING THE METHOD OF CONCRETE CONSTRUCTION



KNIGHTS KEY BRIDGE.



PIERS.



MAP OF THE FLORIDA EAST COAST RAILWAY.

The Florida East Coast Railway has been completed to Key West, and the first train to enter the Island City over a continuous line of steel from the northern terminus at Jacksonville will be that of its sole owner and builder, Henry M. Flagler. Leaving Jacksonville at noon today, his private car and a number of Pullmans bearing a large party of personal friends as his guests, will roll into Key West 582 miles south of Jacksonville, at 9:20 o'clock Monday morning.

This train will be followed by the Congressional Special, bringing the Rivers and Harbors Committee and the committees on Military and Naval Affairs, besides the representatives of several foreign nations who have accepted the invitation of the citizens of Key West to visit the city during the celebration, which will continue for several days. The Congressional delegation will number more than a hundred members. Representatives from the commercial organizations of many cities of the United States will also be on hand to join in paying tribute to Mr. Flagler, who will be Key West's guest of honor for the week.

In his expenditures for railroad construction and hotel building in Florida Mr. Flagler has spent to date approximately $50,000,000. He has invested in his great chain of hotels along the east coast of Florida between $15,000,000 and $12,000,000. The extension of the road from Miami to Key West, which it was estimated would cost not far from $15,000,000, has already involved the expenditure of $20,000,000, and the engineers believe that three years' work will be required to complete it. It has been brought so far toward completion that the operation of regular schedules to Key West will be undertaken immediately from Knight's Key, which for nearly four years has been the southern terminus of the road, and from which point steamers connect with Key West and Havana.

The extension to Key West over the 128 miles from Homestead is one of the greatest engineering feats ever planned in railroad building. The visitor first beholding the great spans and arches of concrete and steel stretching over miles of open water cannot fail to be impressed by the daring which planned and carried into existence this railroad. No one who has not seen for himself can form an adequate estimate of the size of the undertaking. He who has not stood at one end of Knight's Key viaduct and tried in vain to see the farther end lost in the horizon seven miles away, or who has not from a distance endeavored to measure the leagues of trestles, cannot comprehend fully what has been achieved.

To carry out his plans Mr. Flagler chose young men. Foremost in the list is Joseph R. Parrott, a Yale graduate who had a seat in five 'Varsity crews. He is a broad-shouldered, square-jawed man, who came in 1885 fresh from the Yale Law School to join Mr. Flagler's legal forces. His executive ability soon made him the vice-president of the Florida East Coast Railway Company, and the general manager of Mr. Flagler's properties and interests in Florida. Now he is the president of the company.

When in 1902 it was determined to find an outlet for the railroad system at the point farthest south, a survey was ordered to be made from Homestead as a base. For two years the engineers toiled through the jungles and swamps of the Everglades to Cape Sable. They reported against that route and Turtle Harbor on Key Largo became the objective point. It was not long before the order came, "Go to Key West," and the engineers marked out a path through the swamps on the mainland, across the keys rank with the luxuriance of tropical vegetation and over the waters that rolled between.

A YOUNG MAN LED THE WAY.

Through all these pathless wastes that marked the route to Cape Sable and Key West, the surveyors were led by a young man whose name then was not widely known in his profession. He was W. J. Krome.

When the construction of the extension was begun, in 1905, J. C. Meredith, an engineer of reputation, was placed in charge and Mr. Krome became his first assistant. Mr. Meredith was not permitted to see the completion of his task, and he died in April, 1909, from a disorder brought on and aggravated by the demands upon his strength. Mr. Krome was named to take up his work and he is to-day the constructing engineer of the extension.

The division engineers to-day are P. L. Wilson, C. S. Coe and Ernest Cotton, all of them with Mr. Krome members of the Society of American Engineers. R. W. Carter, a bridge engineer, also a member of the same association, has had great responsibility, for it must be remembersd that his is a railroad built over bridges. Edward Sloman has been for years the general foreman of this work. He has directed the handling of all material and the employment of labor.

When construction was begun there were no precedents for much of the work. It has all been done by the company itself and not by contract. These men had to make precedents. They encountered numerous problems that railroad builders had never before had to overcome, or they had to make new applications of methods that had already been devised.

They found ready for them only the air they breathed. Water for drinking and bathing, food for hundreds and thousands of men, and every pound of material used in construction had to be brought from a distance. No wonder that Mr. Meredith's words are often recalled: "No man has any business being connected with this work who can't stand grief."

Hardly less descriptive is the remark of Mr. Krome: "We have put things through because we had to".

LESSON OF THE STORM OF 1909.

As a suggestion of some of the difficulties that had to be met it may be said that the engineering plans for the work originally contemplated six miles of open water spanned by bridges of concrete or steel. It was calculated that allowance need be made only for the ebb and flow of the ocean tides, that only as much tide water could flow back into the ocean as had already passed in through the arches and piers of the bridges. The great autumnal storm of 1909 swept away this idea and revolutionized the plans of construction.

The great tropical storms that come tearing up from the Caribbean and the West Indies force the water before them through the Gulf of Florida. Between Cape Sable and Key West this body of water spreads out a hundred miles wide, but further north and along the eastern coast of the mainland it narrows almost to a meeting point between the mainland and the keys not far south of Miami. This great influx of water cannot flow back the way it came and it must find an outlet between the keys and reefs into the ocean.

The storm of 1909 swept away miles of wooden trestle that had been built across the shallower waters and filled with rock and earth embankment. Great rocks, weighing many tons each, were carried away and the loss amounted to hundreds of thousands of dollars. The result was the decision that instead of six miles of open water, spanned by bridges, there must be eighteen miles. It meant delay in completing the work, and it involved the expenditure of additional millions of dollars, but from Mr. Flagler came the order: "Go ahead," and the engineers have gone ahead leading four thousand men to the accomplishment of the task.

The storm of 1909 also taught another lesson. It was seen that the peaceful waters of the quiet June day may become a seething whirlpool of destruction in October. The filled embankment must have its place in the long line of roadbed, and it must be guarded against the fury of even the shallower waters.

The engineers studied the destructive force of the ocean wave. They discovered that its greatest damaging force is not in the impact against the resisting body, but in its retreat or the undertow, which tears down and carries away. The ballast and material which had been carried away was not battered down by the attacking wave, but was carried back with it in its retreat to the sea.

THE WAVES FOILED.

The solution? Yes, this problem has been solved. How? By presenting a surface over which the advancing wave glides as over a piece of glass, and retreating gains no hold for its work of destruction. The material was found in the marine marl, or coral rock, which occurs in plentiful deposits along the line of the road.

This rock, 52 per cent. carbonate of lime, is found in a thick plastic mass, dazzling white in color, which on exposure to air and sun becomes harder and harder as time goes by, and it presents a surface smooth as glass. Spread over the fills and embankments of the construction work, it covers them as with an unbroken, compact plank impervious to the waves and offering no leverage on which they may get a destructive hold.

Still another problem was forced upon these engineers for solution, and it led through many complications. It was the determination of the proper elevation of the bridge work above the water.

From the start it was evident that the rails must be laid beyond the reach of the waves. The wind might at times carry the spray to the tops of the viaducts, but they must be high enough above low mean tide so that the destroying action of the ocean billows could never surmount them. What, then, determines the height of the wave? The depth of the water over which it rolls and to some degree, the extent of the uninterrupted sweep of the winds that raised it. Therefore, the deeper the water the higher must be the bridge which spans it.

Thus the engineers were brought face to face with a question of economical construction. The arched bridge of concrete is more costly than the steel girder laid on concrete piers, but once completed the former needs no repairs and resists the ravages of time. The steel girder must be painted to withstand the action of moisture and, in this climate, the attacks of the salt-laden air. In the course of years, the girder may have to be replaced. It was calculated that the interest on the difference in cost of the two types of bridge would perpetually meet the expense of maintenance of the cheaper—the steel girder mounted upon the concrete pier.

FEAR OF HURRICANES.

Always through these seven, almost eight, years of construction there has weighed upon these engineers the fear of storms. Three times have hurricanes swept up the coast and destroyed or seriously damaged their work, in October of 1906, 1909 and 1910. From each storm have resulted lessons which, as already suggested, have been costly almost beyond estimate.

"No man has ever passed through one of these West Indian hurricanes," said Mr. Krome, "and boasted that he had no fear of it. Indeed, the lack of fear is dangerous.

"The responsibility resting upon every one of our engineers for the safety of his men and for the preservation of the equipment in his charge is heavy. There is no harbor along the entire line of our work that is safe from a hurricane. When it comes we must be ready for it; we must have the workmen well in hand to prevent panic; we must have done all we could to save the machinery and camp outfit.

"We have found it more economical to sink our floating equipment in the most protected waters and when the storm has passed, to raise and repair it and go on with the work as best we may. Sometimes when an approaching storm is forecast, it may not come our way, or its fury may have been exhausted before it reaches us. We may have sunk our barges and derricks and other valuable machinery and the precaution becomes useless and very costly, for we are operating here at an expense of thousands of dollars a day."

In carrying out this work the engineers have been in close touch with the Weather Bureau at Washington. Ten minutes after information has been received at that office of any disturbance likely to affect the east coast of Florida it has been in the possession of the engineering staff down here.

But these engineers through all the years have been studying weather conditions constantly and quite as earnestly as their professional problems. They have consulted their barometers more frequently than their watches. The inquiry most often passing over the telephone line which connects their various offices and stations is: "How does your barometer read?" They have tabulated the results of their study of tropical storms and their contributions to this science will be valuable.

The season for the tropical hurricanes is through the months of August, September and October. During these months no women may remain in the camps, and the engineers who frequently entertain their wives and daughters in their homes at the front must send them away as this season of rough work comes on. During these trying times the responsible men on the work are under heavy strain and their minds must not be burdened with anxiety for their families.

THE LABOR QUESTION.

The question of labor has been one of the most perplexing. Between three thousand and four thousand men have been employed on the work for many months at a time, and particularly during the past year of rush to complete the road. There has been ample opportunity to compare the relative efficiency of various nationalities. The alien labor laws of the United States have forbidden the direct importation of the most desirable classes of workmen, and the engineers have been compelled to rely on those who have offered themselves or who have been recruited through the agencies in New York and Philadelphia.

Native negro labor was found after exhaustive trial to be insufficient and inefficient. Its inevitable accompaniments were women and liquor, and no attempt has been made for five years to use the negroes in gangs.

"One of our most trying problems," said Mr. Krome, "has been to take a big body of low-grade men, take care of them and build them into a capacity for performing high-class work."

And it has been found that the most efficient class of labor, the most economical from every viewpoint, is the Spaniard from Cuba, not the native Cuban, but the Spanish laborer from that island. This class has formed about 20 per cent. of the army of workmen on the keys. The other 80 per cent. has been the miscellaneous assortment which has been gathered from the unemployed in the great Northern cities.

These men have received transportation to the camps on the keys and its cost has been deducted from their wages. It was to be expected that many would use the opportunity to go to the warmer winter climate of the South, and after arriving would desert or refuse to work. Such conduct has been resented by the employing railroad builders, but never has force been used to compel the delinquent to work out the amount of his indebtedness.

The charge of peonage has been made just once against the engineering staff. For almost two years Mr. Meredith and Mr. Krome and the New York employing agent were under indictment in the United States District Court in New York. The prosecution seemed willing to drop the case, but the two engineers persistently fought for a hearing. They got it. They presented no evidence in their defense. It wasn't necessary, for, on motion of their attorneys, the court directed a verdict of not guilty.

Every man engaged in the work receives an agreed salary in addition to his board and lodging. The tables and the sleeping quarters in every camp are provided under contract, but the railroad company keeps close watch over everything pertaining to the comfort of the men, and no lowering of fixed standards is permitted. The menu is substantial, wholesome and bountiful and the occasional visitor finds it appetizing.

In addition the company maintains in each important camp an emergency hospital in charge of two trained orderlies capable of rendering first aid to the injured and of caring for ordinary illnesses. If the case seems to demand extended treatment or serious operation the patient is sent in charge of one of the orderlies by special train to the company's hospitals at Miami or Key West. The patient, whether he be engineer or shovelman, whether he has worked one day or five years for the company, receives this hospital service absolutely free for so long a time as it may be necessary.

The matter of water for drinking and bathing purposes and for other domestic uses, was one of the first and most important problems to be solved. Borings were made in a number of places as deep as two thousand feet through the limestone and coral rock along the keys, to find an adequate supply of potable water, but without satisfying results. To meet the need, two special trains of flat cars, carrying tanks of wood or of metal, are operated daily from the little station of Everglades, not far south of Homestead. Here a tank of 100,000 gallons capacity is supplied with clear water from the Everglades, pumped by engines of large power, and this is the source of the water supply for the thousands of men working in the keys.

THROUGH THE SWAMPS OF THE EVERGLADES

The construction of the road over these one hundred and twenty-eight miles has presented a variety of propositions hardly equaled by railroad work anywhere else in the world. The building of the roadbed south from Homestead was through the swamps of the Everglades. The land was low and partially covered with shallow water. It could not be graded with any appliances ever used for such purposes.

To meet the emergency the engineers constructed dredges that would float in shallow water, and started them southward, each eating out a channel for itself and discharging its shovelfuls of mud in the space between them. This material was the marl, or coral rock, already described, which formed the grade for the rails, as firm and solid when it became hardened, as the best rock-ballasted right of way in the United States. To-day a canal from twenty to thirty feet wide borders the road on either side for many miles on the mainland before it reaches the keys.

BRIDGES BY THE MILES.

Across the keys the construction more closely resembled that of ordinary railroad building. There were dense jungles of vegetation to be penetrated, but it was largely a matter of perseverance and unusual hardship. It was when open water was reached that the most serious problems and difficulties were encountered. Some of these have been described.

Three grat viaducts spanning wide gaps of water between the keys, are typical of all. Long Key bridge, two and three-quarter miles in length, built on arched spans, is perhaps the most picturesque. These arches, each eighty feet long, were built of trap rock brought from Clinton, on the Hudson River, and set in heavily reinforced concrete. This bridge was among the most expensive pieces of work along the entire line.

Knight's Key bridge, stretching a little less than seven miles, is carried five miles on eighty-foot deck plate steel girders, laid on unreinforced concrete piers, and two miles on arches. The rails are laid twenty-nine feet, nine inches above mean low tide level.

The Bahia Honda bridge is 5,056 feet long. It is of the through truss type, in which the iron construction rises many feet above the track level and flanks the moving train on either side. In this bridge are thirteen spans, each of 128.5 feet long; thirteen spans, each 180 feet long; one span, 247.5 feet long, and nine arches of concrete, each 80 feet long.

It was intended originally to place in this structure a draw bridge, but after the plans had been made, the United States Government directed that this draw should be built in the Knight's Key bridge over the Moser Channel, a direct passage connecting the Atlantic with the Gulf of Mexico. Three draws besides this, have been constructed in this roadway; one at Key West, one at Indian Key and one over Jew Fish Creek.

The deepest water of the construction work was found in the building of Bahia Honda bridge, approximately thirty feet to bed rock. The roadbed is carried thirty feet above the ordinary level of low tide.

THE CONCRETE WORK.

The below-water construction of arches and piers is the same. Not only must these supports rest upon the solid rock, but the engineers decided that they must be immovably anchored to it. The process of building these foundations was one of the problems to be solved by the engineers, and this was the plan they adopted.

The location of the pier being determined, a coffer dam was floated into place on a catamaran, two immense lighters arranged to carry it and launch it where it was wanted. As soon as it rested on the bottom, the soft mud overlying the bed rock was removed, although the water level was not reduced inside the coffer dam. Into the rock beneath a steel punch was driven to make places for the wooden piles which were to follow. Twenty-four of these piles, driven into the rock as far as they could be forced in the path made by the steel punch, were made the anchors for each pier.

The next operation was to sink to the bedrock through specially devised pipes a large quantity of cement brought from Germany, which has the property of hardening under water. It formed a solid and compact union with the underlying rock and incidentally served to make the coffer dam practically water tight at the bottom. This was then pumped dry, the piles already encased in the cement foundation above the rock were sawed off below the low-tide level and the forms or molds for the pier base were put in place.

This was built up of the German cement to ap oint a few inches above the tide level and was kept in the form for seven days to permit hardening, before the water was admitted and the cofferdam removed. Upon this base the pier or arch was built to the determined height.

In the construction of the arches they were not built one after the other, but the alternate arches were constructed of American concrete and were allowed to harden in the forms and over the arch rings for twenty-eight days. Then the missing arches were put in and were joined to those already in place by an interlocking device which held them firmly in position and closely united each to its neighbor. Thus, each arch is a separate piece of concrete and its shrinkage as it turns into rock, cannot affect that of any other.

The sleepers used on the bridges of the extension are sawed oak ties, ten by twelve inches and eleven feet long, laid six inches apart and held to the girders by hook bolts.

PRECAUTIONS AGAINST HURRICANES.

The matter of operating trains over this extension had full consideration from the engineers, who determined long ago the limits of safety. The possibility of storms, such as have been described, must make extra hazardous the operation of trains exposed to their fury. During the hurricane of 1909 the wind reached a velocity of 125 miles an hour, and the lowest barometrical reading ever recorded in the United States, was reached here. Even this test brought not the slightest damage to the great arches and bridges that the engineers had pro-

Continued on Fifth Page.